EMPLOYMENT IMPACTS OF

GEOTHERMAL ELECTRIC PROJECTS

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FILE: [JOBS-DOC]

DISCLAIMER

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1.0 SUMMARY

Table 1 summarizes the number of jobs associated with the development and operation of a 50 MW geothermal dual flash power system. The values shown are person years (PY) of employment for the 50 MW system.

About 1500 person years (PY) of labor are incorporated in the manufacture and installation of capital components of the system. Of these, about 300 PY are local to the area of the geothermal system, and about 1200 are dispersed elsewhere in the U.S. or other countries.

About 71 PY of labor per year are required for the operation of the system. Of those, about 39 PY are local to the plant, and about 32 are dispersed.

The total person years of labor over the entire life cycle of such a system, assuming a 30-year operational life, is on the order of 3630 person years. These include jobs during the 5 to 10 years of exploration and construction activities prior to plant start up. Of these jobs, about 1470 PY are local to the system, and about 2160 are dispersed elsewhere.

TABLE 1

SUMMARY OF GEOTHERMAL ELECTRIC SYSTEM JOBS

System Item	Jobs		
	Local	Dispersed	Total
1. Construction Phase	(Person years)		
a. Well Field	220	470	690
b. Power Plant	80	730	810
c. Total	300	1200	1500
2. Operations Phase	(Person years per year)		
a. Well Field	19	6	25
b. Power Plant	20	26	46
c. Total	39	32	71
3. Life Cycle	(Person years)		
a. Well Field	790	650	1440
b. Power Plant	680	1510	2190
c. Total	1470	2160	3630

A few aspects of these estimates deserve further explanation.

(1) The estimates are for a geothermal flashed-steam electric system with specific characteristics. This system is of moderate cost as such systems go. Binary systems, used at lower-temperature resources, cost somewhat more and will have somewhat higher levels of embedded labor, e.g., perhaps 50 to 70 percent more overall for the power plant portion of the project.

(2) The splits shown for local and distributed labor entail a fair amount of local construction. If the power plant components are modularized, e.g., delivered to the site as skid-mounted equipment - - the practice for some binary plants, then some jobs will be shifted from local construction to dispersed manufacturing operations.

(3) Of the 300 PY construction-phase jobs local to the plant, about 125 are related to the exploration and initial confirmation of the presence and productive capacity of the geothermal reservoir. Not all of these jobs will be strictly local to the power plant site, since some of that effort includes unsuccessful exploration work at other sites.

(4) If the turbine-generator is imported, as is often the case, most of the dispersed 425 PY for that component would be performed outside of the U.S.

(5) Employment impacts of production royalties and local property taxes are not included in Table 1. These are estimated to produce about 40 local and 6 dispersed PY of employment per year.

(6) The accuracy of the values in Table 1 is estimated by the analyst to be on the order of plus or minus 15 percent.

2.0 METHOD

Most reports on the cost of geothermal electric projects contain no estimates of the labor associated with the project. While the detailed engineering cost estimates prepared during the course of such projects contain such estimates, those are rarely published.

One fairly detailed estimate of local construction labor requirements for a dual flash plant was found [1]. This included cost estimates for purchased equipment and subcontracts for some local services. It did not include estimates for the costs or jobs associated with the geothermal field. The plant cost was estimated for a 400 degree-F reservoir with minimal brine chemistry problems.

Geothermal field costs and all Operating and Maintenance costs were estimated using the IMGEO hydrothermal electric cost of power model [2]. This is one of the few available sources of estimates of current field-related costs. The system modeled is similar to that at Dixie Valley, Nevada: The fluid contains a moderate amount of noncondensible gases and the degree of reservoir pressure decline is low.

General definitions of the scope of activities involved in geothermal electric project construction and operation are listed in Table 2.

Estimates of the jobs embedded in purchased equipment and services were prepared using statistics from the Statistical Abstract of the United States [3]. The factors used are shown in Table 3. The derivation and details of the factors are described in the Appendix.

The job values shown are full time equivalents, either for the 50 MW net geothermal system, or per million dollars of expense. Cost values shown are 1990 dollars. Numbers of jobs are rounded to the nearest full person year in Tables 4, 5, 6, and 7. In Table 1, Construction Phase jobs are rounded to the nearest ten jobs, so as not to convey a false sense of accuracy.

Indirect employment resulting from personal expenditure of wages are not estimated here. For local employment, one source [4] indicates that there is on the order of one indirect local job for each direct local job estimated here. However, that ratio is probably lower for the geothermal field jobs during exploration, since a substantial portion of that work is performed by persons who do not reside locally.

TABLE 2

SCOPE OF LABOR AND COST ELEMENTS

Project Phases and Elements	Scope of Activities and Costs
A. Exploration	
1. Surveys and Analysis	Geological and geophysical surveys and analysis. Analysis of reservoir potential. Environmental surveys and reports.
2. Wells	Wildcat production wells drilled during exploration and reservoir confirmation stages of project. Includes flow tests of wells.
B. Construction	
1. Well Field	Production and injection wells. Piping between wells and the power plant, and labor to install that piping.
2. Major Equipment	Power plant: Flash tanks, heat exchangers, turbine generators, condensers, cooling towers, major pumps, system controls.
3. Construction Materials	Power plant: Structural steel, concrete, process piping.
4. Construction Labor	Power plant: On-site construction labor.
C. Operation	
1. Field	On-site O&M labor. Labor in purchased services.
2. Plant	On-site O&M labor.
3. Local Office	On-site project management and clerical labor.
4. Headquarters	Company headquarters labor related to project. Management, legal, general engineering, and general administration.
5. Royalties and Taxes	Jobs from government expenditures of geothermal project payments for resource royalties and local property taxes.
D. Types of Jobs	
1. Local	Jobs near the project site due to work performed at or near the site.
2. Dispersed	Non-local jobs due to project expenditures for equipment or services where the labor occurs at some distance from the project site.

TABLE 3

FACTORS FOR CONVERTING COST OUTLAYS TO JOBS

Factor I.D. Code	Factor Definition	Jobs Factor Value (Person Years per $Mn)		
		Local	Distributed	Total
F-1	Engines and Turbines	0.	18.8	18.8
F-2	Other Industrial Machinery	0.	19.1	19.1
F-3	Electrical Industrial Apparatus	0.	19.6	19.6
F-4	Fabricated Metal Products	0.	23.3	23.3
F-5	Heavy Construction, n.e.c. (a)	8.5	10.7	19.2
F-6	Concrete Foundations, etc.	11.3	12.0	23.3
F-7	Excavation	8.7	9.8	18.5
F-8	Construct Industrial Buildings	4.7	19.3	24.0
F-9	Roads	6.4	14.4	20.8
F-10	Pipes and Installation	8.9	11.6	20.5
F-11	Oil & Gas Field Services, General	10.4	10.5	20.9
F-12	Drilling Oil & Gas Wells	6.3	16.2	22.5
F-13	Oil & Gas Exploration Services	10.8	11.1	21.9
F-14	Oil & Gas Services, n.e.c.	9.8	10.8	20.6
F-15	Composite Industrial Purchases (b)	-	22.9	22.9
F-16	U.S. General Economy	-	26.4	26.4
F-17	State and Local Government (c)	11.8	11.8	23.7
F-18	Heavy Construction Contractors (b)	-	-	-
F-19	Concrete Manufacturing (b)	-	-	-
F-20	Fabricated Metal Products (b)	-	-	-

Notes:

a) "n.e.c." means "not elsewhere classified" in SIC codes.
b) Factors 18, 19, and 20 are used only to form the basis for Factor F-15.
c) Split 50:50 between local and State government.

3.0 RESULTS

The results are presented as a set of tables. The totals from the various tables were summed to create the summary, Table 1. The tables here are:

Table 4: Jobs associated with geothermal field capital expenses

Table 5: Jobs associated with power plant construction local labor taken directly from reference [1]

Table 6: Jobs associated with power plant-related purchased equipment and services (including some local labor associated with subcontracts)

Table 7: Jobs associated with well field and power plant operations and maintenance

Table 8: Notes on selected aspects of cost estimates.

TABLE 4

JOBS FROM FIELD CAPITAL PURCHASES

System Component	Purchases, $Mn	Factor for Jobs per $Mn	Jobs (Person Years)	
			Local	Dispersed
a. Exploration Wells	15.9	F-12	100	258
b. Exploration Services	2.5	F-13	27	28
c. All Other Wells in Construction Phase	8.4	F-12	53	136
d. Other Field-Related Services	1.0	F-14	10	11
e. Field Piping	3.2	F-10	28	37
TOTAL	31.0		218	470

TABLE 5

LOCAL JOBS FROM POWER PLANT INSTALLATION

System Component	Jobs (Person Years)
a. Turbine Generator	5
b. Mechanical Auxiliary	9
c. Piping	8
d. Electrical Equipment	8
e. Civil and Structural	16
f. Yard Work	4
TOTAL	50

TABLE 6

JOBS FROM POWER PLANT CAPITAL PURCHASES

System Component	Purchases, $Mn	Factor for Jobs per $Mn	Jobs (Person Years)	
			Local	Dispersed
a. Turbine Generator	22.71	F-1	0	426
b. Other Mechanical Equipment	4.80	F-2	0	91
c. Piping Subcontracts	0.22	F-10	2	3
d. Piping Purchases	2.83	F-4	0	66
e. Electrical Equipment	3.08	F-3	0	60
f. Civil & Structural Subcontracts	0.39	F-7	3	4
g. Civil & Structural Purchases	0.57	F-15	0	13
h. Yard Work Subcontracts	2.33	F-5	20	25
i. Yard Work Purchases	0.56	F-9	4	8
j. Field Indirect Costs	0.67	F-15	0	15
k. Management & Administration	0.82	F-15	0	19
TOTAL	39.0		29	730

TABLE 7

JOBS FROM OPERATIONS AND MAINTENANCE ITEMS

System Component	Expense, $Mn/Year	Factor for Jobs per $Mn	Jobs (Person Years)	
			Local	Dispersed
Field O&M				
a. General Labor on Site	0.5	33 (a)	16	0
b. Make-up Wells	0.3	F-12	2	5
c. Miscellaneous Field Services	0.1	F-14	1	1
Field Subtotal	0.9		19	6
Power Plant O&M				
d. General Labor on Site	0.8	25 (a)	20	0
e. Miscellaneous Expenses	1.0	F-16	0	26
Plant Subtotal	1.8		20	26
TOTAL	2.7		39	32

NOTES: (a) From Reference [4].

TABLE 8

COST ESTIMATION NOTES

Factor Identification		Notes
Table or Page	Factor	
Table 4	a, b	Exploration costs include some costs for wildcat exploration at sites possibly distant from the project site. Therefore not all of the jobs estimated for this element are "local" in the strictest sense.
Table 6	All costs	Power plant costs were stated in reference [1] in 1977 dollars. These were inflated to 1990 dollars using the U.S. general Producer Price Index, 1.859. The estimates include a 10 percent contingency, and were adjusted to a plant size of 50 MW net.
Table 6	f	Power plant: Most of Yard Work subcontract cost is for purchase and installation of cooling towers.
Table 6	h	Power plant: Most of Civil and Structural subcontract cost is for excavation.
Page 2	Royalties (5)	Royalties are estimated to be 10 percent of well-field (not power plant) annual costs, and total about $ 0.34 Mn per year. Since most geothermal projects are on Federal leases, the royalty payments are assumed to be distributed one quarter each to local and State governments, and half to the Federal government.
Page 2	Property Taxes (5)	Property taxes are estimated to be 2 percent of the capital cost of the system, exclusive of wildcat exploration costs. They total about $1.6 Mn per year.

4.0 REFERENCES

[1] Eskesen, J.H., Study of Practical Cycles for Geothermal Power Plants, General Electric Company, Schenectady, NY, U.S. Department of Energy Report COO-2619-1, April 1977.

[2] Entingh, D.J, IMGEO Geothermal Hydrothermal Cost of Power Model, Version 4.0B, BNF Technologies Inc., Alexandria, VA, and NOVA Analytics, Falls Church, VA, February 1993.

[3] Statistical Abstract of the United States 1992, U.S. Department of Commerce, Washington, DC, 1992.

[4] Sifford, A. and K. Beale, "Economic Impacts of Geothermal Power Development in Harney County, Oregon, Geothermal Resources Council Transactions, 1991, p. 113.

APPENDIX:

DERIVATION OF FACTORS FOR

ESTIMATING JOBS FROM COST OUTLAYS

FILE: [JOBS-APX]

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1.0 BACKGROUND

The purpose of the materials in this Appendix is to estimate the number of full time equivalent jobs that result from purchase of various equipment and services.

Establishing such conversion factors was necessary because, for many of the activity and cost categories in the report, data were available for costs but not for jobs. This affects estimates of both local and dispersed jobs. For example, consider the following two cases:

a) For geothermal wells, there were cost estimates, but no direct estimate of labor involved locally in drilling the wells nor of labor embedded in drilling and completion materials consumed at the site.

b) For turbine generators, there was a direct estimate of the labor needed to install equipment at the site, but there was no estimate of the labor embedded in the purchased equipment delivered to the site or in some subcontracted services that include local labor.

2.0 METHOD AND RESULTS

Data in tables in the Statistical Abstract of the United States, 1992 Edition, (compiled by the Department of Commerce) provided the basis for reasonable estimates of the employment impact of sales and expenditures in various industries.

The results from the analysis are shown in Table A-1. The reader should consult that table to understand the steps of the method.

The industry name used in Table A-1 generally follows that used in the Statistical Abstract of the United States, but has been modified in places to make clearer the industry relevance to a particular geothermal cost account.

In general, the calculations proceeded as follows for each industry or other jobs category:

1. Total sales for the industry (row e. of Table A-1) was assumed to represent what the industry would be paid by the purchasing firm.

2. Value added by the industry (row f.) was subtracted from total sales to find the direct purchases of the industry, i.e., materials and supplies purchased for consumption in producing the goods or services supplied by the industry (row g.).

3. The number of production workers (row i.) and other workers (row j.) in the industry was tabulated.

4. The number of production workers per $ million sales was calculated (row l.), as was the number of other workers per $ million sales (row m.).

5. There is also labor embedded in the direct purchases of each industry. To estimate the "indirect jobs," a reasonable guess was made as to what secondary industry (row n.) absorbed most of the direct purchases (row g.) of the primary industry (the industry represented by the column in Table A-1). The indirect jobs (row o.) were estimated

based on the total jobs per $ million sales of the secondary industry.

6. The final estimates for employees per $ million of sales or direct purchases were transferred to Table 3 in the body of the report, "FACTORS FOR CONVERTING COST OUTLAYS TO JOBS." In this process, "Local Jobs" in Table 3 were assumed to be those denoted as "Production Workers" (row l. in Table A-1) for contracted services that include a local labor component, e.g., Factor F-12, Drilling Wells and Factor F-6, Concrete Installation Subcontracts. The remaining labor (sum of row m. and row o.) were assigned to the "Dispersed Labor" category in Table 3.

   For factors where all of the associated labor can be assumed to occur off-site, e.g., Factor F-1, Turbines and Generators, all of the labor ("Total Jobs," row p. in Table A-1) were assigned to the "Dispersed" category in Table 3.

The total payroll line (row h.) and average wage line (row k.) in Table A-1 are shown for general interest, and were not used in the analysis.

Various technical notes for the analysis are shown in Table A-2.

TABLE A-1

EMPLOYMENT FACTORS BY INDUSTRY (Page 1 of 7)

Industry and Jobs Characterization	F-1	F-2	F-3
a. Industry Name	Engines & Turbines	Industrial Machinery & Equipment	Electrical Industrial Apparatus
b. Industry SIC Code	351	35	362
c. Source Table Number, Stat. Abstr. U.S. 1992	1244	1244	1244
d. Year of primary data	1990	1990	1990
Statistics	(Annual values for the industry)		
e. Total sales, $Mn	16,581	256,345	18,159
f. Value added, $Mn	7,159	132,166	10,127
g. Direct purchases, $Mn	9,422	124,179	8,032
h. Total payroll, $Mn	2,976	56,424	4,207
i. Production workers	56,000	1,184,000	109,000
j. Other workers	27,000	703,000	53,000
k. Average wage, $	$ 35,860	$30,060	$25,970
Job Estimates	(Employees per $Mn of sales or direct purchases)		
l. Production workers	3.4	4.6	6.0
m. Other workers	1.6	2.7	2.9
n. Factor for indirect jobs	F-4	F-4	F-4
o. Indirect jobs	13.8	11.8	10.7
p. Total jobs	18.8	19.1	19.6

Notes: d. Job estimates are adjusted to 1990 values.
l., m. Production and other workers within this industry
o. Indirect jobs outside this industry due to g., Direct purchases

TABLE A-1

EMPLOYMENT FACTORS BY INDUSTRY (Page 2 of 7)

Industry and Jobs Characterization	F-4	F-5	F-6
a. Industry Name	Fabricated Metal Products	Heavy Construction, n.e.c	Concrete Installation Subcontracts
b. Industry SIC Code	344	1629	1771
c. Source Table Number, Stat. Abstr. U.S, 1992	1244	1021	1201
d. Year of primary data	1990	1987	1987
Statistics	(Annual values for the industry)		
e. Total sales, $Mn	44,936	25,633	15,056
f. Value added, $Mn	19,935	15,301	8,443
g. Direct purchases, $Mn	25,001	10,332	6,613
h. Total payroll, $Mn	9,991	7,662	4,175
i. Production workers	289,000	238,000	187,000
j. Other workers	117,000	40,000	31,000
k. Average wage, $	$ 24,610	$ 25,710	$19,150
Job Estimates	(Employees per $Mn of sales or direct purchases)		
l. Production workers	8.2	8.5	11.3
m. Other workers	2.4	1.5	1.9
n. Factor for indirect jobs	F-15	F-15	F-15
o. Indirect jobs	12.7	9.2	10.1
p. Total jobs	23.3	19.2	23.3

Notes: d. Job estimates are adjusted to 1990 values.
l., m. Production and other workers within this industry
o. Indirect jobs outside this industry due to g., Direct purchases

TABLE A-1

EMPLOYMENT FACTORS BY INDUSTRY (Page 3 of 7)

Industry and Jobs Characterization	F-7	F-8	F-9
a. Industry Name	Excavations	Industrial Buildings	Highway and Street Construction
b. Industry SIC Code	1794	1541	1161
c. Source Table Number, Stat. Abstr. U.S. 1992	1201	1201	1201
d. Year of primary data	1987	1987	1987
Statistics	(Annual values for the industry)		
e. Total sales, $Mn	8,244	21,462	34,161
f. Value added, $Mn	5,708	6,882	17,120
g. Direct purchases, $Mn	2,536	14,580	17,041
h. Total payroll, $Mn	2,060	3,619	7,041
i. Production workers	79,000	111,000	239,000
j. Other workers	16,000	32,000	45,000
k. Average wage, $	$ 21,680	$ 25,310	$ 24,790
Job Estimates	(Employees per $Mn of sales or direct purchases)		
l. Production workers	8.7	4.7	6.4
m. Other workers	1.7	1.4	1.2
n. Factor for indirect jobs	F-16	F-16	F-16
o. Indirect jobs	8.1	17.9	13.2
p. Total jobs	18.5	24.0	20.8

Notes: d. Job estimates are adjusted to 1990 values.
l., m. Production and other workers within this industry
o. Indirect jobs outside this industry due to g., Direct purchases

TABLE A-1

EMPLOYMENT FACTORS BY INDUSTRY (Page 4 of 7)

Industry and Jobs Characterization	F-10	F-11	F-12
a. Industry Name	Water, Sewer & Utility Lines	Oil & Gas Field Services, General	Drilling Oil & Gas Wells
b. Industry SIC Code	1623	--	--
c. Source Table Number, Stat. Abstr. U.S. 1992	1201	1167	1167
d. Year of primary data	1987	1987	1987
Statistics	(Annual values for the industry)		
e. Total sales, $Mn	17,010	11,095	6,626
f. Value added, $Mn	10,090	8,069	2,549
g. Direct purchases, $Mn	6,920	3,026	4,077
h. Total payroll, $Mn	4,513	4,018	1,318
i. Production workers	166,000	127,000	46,000
j. Other workers	32,000	40,000	9,000
k. Average wage, $	$ 22,790	$ 24,060	$ 23,964
Job Estimates	(Employees per $Mn of sales or direct purchases)		
l. Production workers	8.9	10.4	6.3
m. Other workers	1.7	3.3	1.3
n. Factor for indirect jobs	F-4	F-16	F-4
o. Indirect jobs	9.9	7.2	14.9
p. Total jobs	20.5	20.9	22.5

Notes: d. Job estimates are adjusted to 1990 values.
l., m. Production and other workers within this industry
o. Indirect jobs outside this industry due to g., Direct purchases

TABLE A-1

EMPLOYMENT FACTORS BY INDUSTRY (Page 5 of 7)

Industry and Jobs Characterization	F-13	F-14	F-15
a. Industry Name	Oil & Gas Exploration Services	Oil & Gas Services, n.e.c.	Composite Industrial Purchases
b. Industry SIC Code	--	--	--
c. Source Table Number, Stat. Abstr. U.S. 1992	1167	1167	See factors F-18,19 and 20
d. Year of primary data	1987	1987	1990
Statistics	(Annual values for the industry)		
e. Total sales, $Mn	1,096	6,373	94,996
f. Value added, $Mn	771	4,748	46,898
g. Direct purchases, $Mn	325	1,625	48,098
h. Total payroll, $Mn	452	2,248	22,459
i. Production workers	13,000	69,000	899,000
j. Other workers	4,000	26,000	--
k. Average wage, $	$ 26,590	$ 23,660	$ 24,980
Job Estimates	(Employees per $Mn of sales or direct purchases)		
l. Production workers	10.8	9.8	9.5
m. Other workers	3.3	4.1	--
n. Factor for indirect jobs	F-16	F-16	F-16
o. Indirect jobs	7.8	6.7	13.4
p. Total jobs	21.9	20.6	22.9

Notes:
d. Job estimates are adjusted to 1990 values.
l., m. Production and other workers within this industry. For F-15, all direct workers are listed as production workers.
o. Indirect jobs outside this industry due to g., Direct purchases

TABLE A-1

EMPLOYMENT FACTORS BY INDUSTRY (Page 6 of 7)

Industry and Jobs Characterization	F-16	F-17	
a. Industry Name	U.S. General Economy	State & Local Governments	
b. Industry SIC Code	--	--	
c. Source Table Number, Stat. Abstr. U.S. 1992	626, 679	450, 456, 633	
d. Year of primary data	1990	1990	
Statistics	(Annual values for the industry)		
e. Total sales, $Bn	4,460	1,212	
f. Value added, $Bn	--		
g. Direct purchases, $Bn	--	508	
h. Total payroll, $Bn	2,739	351	
i. All workers, Mn	117.9	15.24	
j. Other workers	--	--	
k. Average wage, $	$ 23,230	$ 23,040	
Job Estimates	(Employees per $Mn of revenues)		
l. Production workers	--	12.6	
m. Other workers	--	--	
n. Factor for indirect jobs	--	F-16	
o. Indirect jobs	--	11.1	
p. Total jobs	26.4	23.7	

Notes:
d. Job estimates are adjusted to 1990 values.
e. - i. Dollars here are billions, and numbers of employees are millions.
l., m. Production and other workers within this industry. For F-17, all direct workers are listed as production workers.
o. Indirect jobs outside this industry due to g., Direct purchases

TABLE A-1

EMPLOYMENT FACTORS BY INDUSTRY (Page 7 of 7)

Industry and Jobs Characterization	F-18	F-19	F-20
a. Industry Name	Heavy Construction n.e.c.,	Concrete Manufacturing	Fabricated Structural Metal Products
b. Industry SIC Code	1629	327	344
c. Source Table Number, Stat. Abstr. U.S. 1992	1201	1244	1244
d. Year of primary data	(1987)	1990	1990
Statistics	(Annual values for the industry)		
e. Total sales, $Mn	25,633	24,427	44,936
f. Value added, $Mn	15,301	11,662	19,935
g. Direct purchases, $Mn	--	--	--
h. Total payroll, $Mn	7,662	4,806	9,991
i. All workers	298,000	195,000	406,000
j. Other workers	--	--	--
k. Average wage, $	--	--	--
Job Estimates	(Employees per $Mn of sales or direct purchases)		
l. Production workers	--	--	--
m. Other workers	--	--	--
n. Factor for indirect jobs	--	--	--
o. Indirect jobs	--	--	--
p. Total jobs	--	--	--

Notes: a. Factors F-18, F-19, and F-20 are used only to derive the value for Factor F-15.
l., m. Production and other workers within this industry
o. Indirect jobs outside this industry due to g., Direct purchases

TABLE A-2

NOTES ON ASSUMPTIONS AND ESTIMATES

Item	Notes
Payroll costs are for wages only	The payroll cost (row h. in Table A-1) is for wages only. It does not include the industry expense for non-wage benefits.
Full-time nature of the jobs estimated here	The jobs per $ million estimated here are full-time equivalent jobs. From various tables in the Statistical Abstract of the U.S., the average 1987 or 1990 hours per employee in various industries was typically shown as 43 to 44 hours per week. For U.S. labor in general, Factor F-16 here, it was calculated from Table 626 that employment across all workers in 1990 averaged 39.4 hours per week.
Factor F-15, Composite Industry Purchases	Factor F-15 is used only as a secondary industry. This is a composite formed during this analysis by adding all sales and labor values from factors F-18, F-19, and F-20, Construction, Concrete Manufacturing, and Fabricated Structural Metal Products.
Adjustment of 1987 cost factors to 1990 dollars	In some cases the primary detailed data on industry sales and employment from the Statistical Abstract of the United States were dated 1987. In those cases, the cost values for the industry are shown as 1987 values, but the Job Estimates (Employees per $ million) are shown as 1990 values. This conversion was made under the assumption that costs had inflated over the three year interval, but that neither wages nor worker productivity had changed. The inflation factor used was the Producer Price Index for Capital Equipment. Its value is 122.9/111.7 = 1.100.